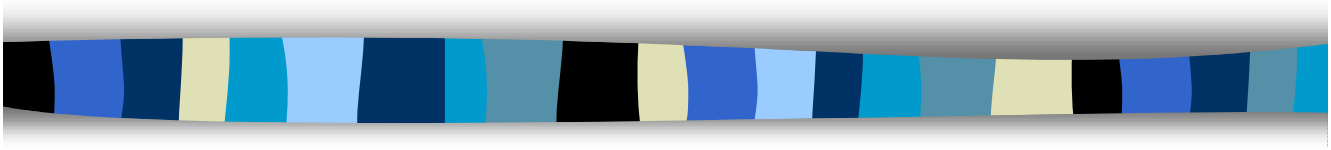
Exploring Steganography: Seeing the Unseen



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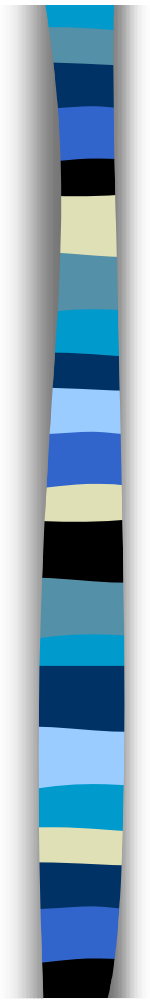


Introduction to Steganography

- *What*
  - Steganography literally means “covered writing”, takes one piece of information and hides it within another.
- *Why*
  - You are working at a company that does not allow encrypted email, and you want to send a “secret message”.
  - You are resident of a country that does not allow encrypted communication, and you want to send a secret.
- *How*
  - Steganography takes advantage of unused or insignificant areas of data in computer files (images, sounds recordings, etc.), replacing it with information to be hidden.

Brief Review of Image File Formats

- Colour (Gray-scale) representation of images
  - 256 colours (8 bits per pixel = 1B / pixel)
  - 16M colours (24 bits / pixel = Red + Green + Blue)
    - e.g. 1024 columns x 768 rows x 3B / pixel = 2.3 MB
- Compression
  - Lossless (GIF, 8-bit BMP format)
  - Lossy (JPEG format)
    - Reduces an image file to about 5% of its normal size

Embedding Data

- Cover image file - holds the hidden message
- Message file - the message to be hidden. Formats:
  - plaintext
  - ciphertext
  - image
- Stego_key - password, to be used to encrypt and decrypt the message

Steganographic Methods

Information can be hidden in many different ways in an image. According to this article, steganographic methods can be categorised into:

- least significant bit insertion (my focus)
- masking and filtering
- algorithms and transformations

Least Significant Bit Insertion

- Information can be hidden in the least significant bits of an image.

  E.g. In a 24-bit image with 1024x768 pixels, we can store 3 bits in each pixel (1 bit / Byte), so 1024x768x3 bits = 29.5 KB can be hidden in this 2.3 MB file.

Least Significant Bit Insertion

- Let's hide 'A' = 10000011 in 24-bit image data. (Example from the paper.)

  Suppose 3 24-bit pixel values (9B) are

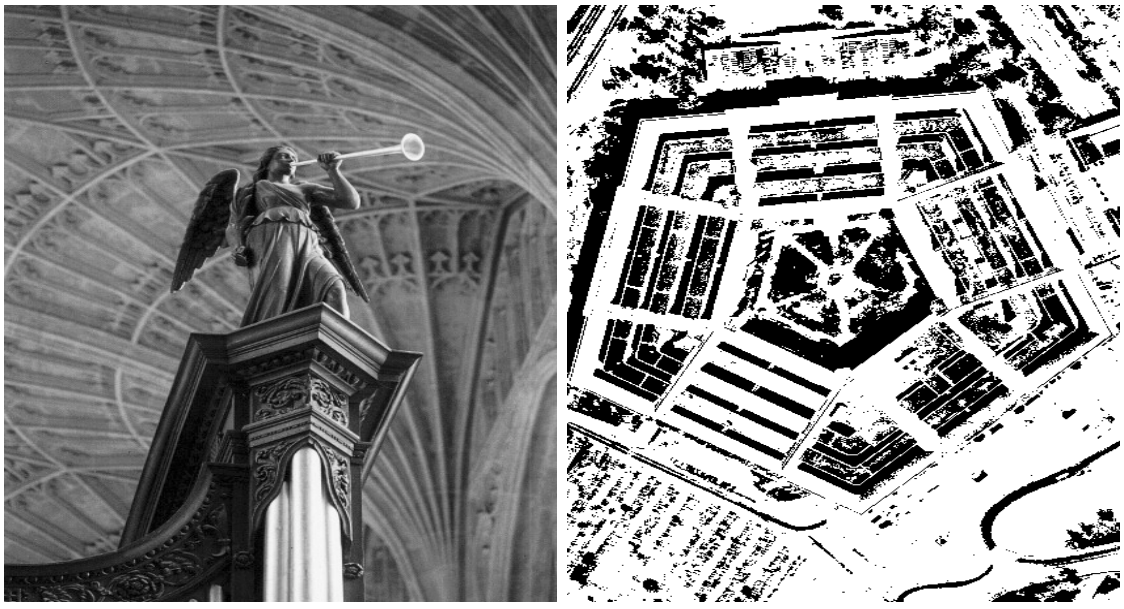
  00100111 11101001 11001000
  00100111 11001000 11101001
  11001000 00100111 11101001

  After the insertion, the raster data becomes:

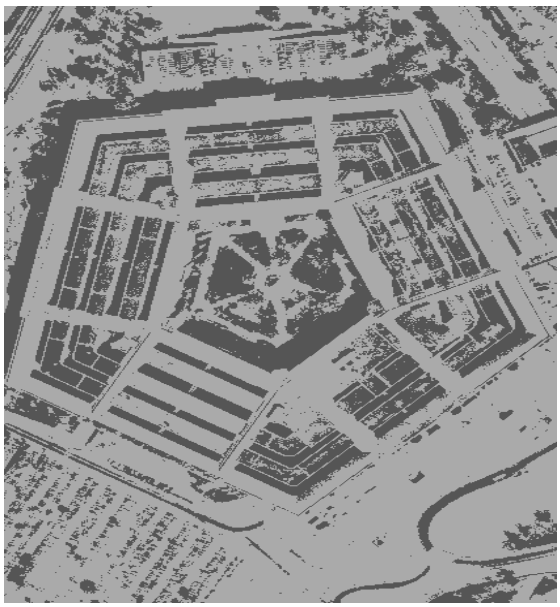
  00100111 11101000 11001000
  00100110 11001000 11101000
  11001000 00100111 11101001

Is there an error in the article's example? A = 100000011?

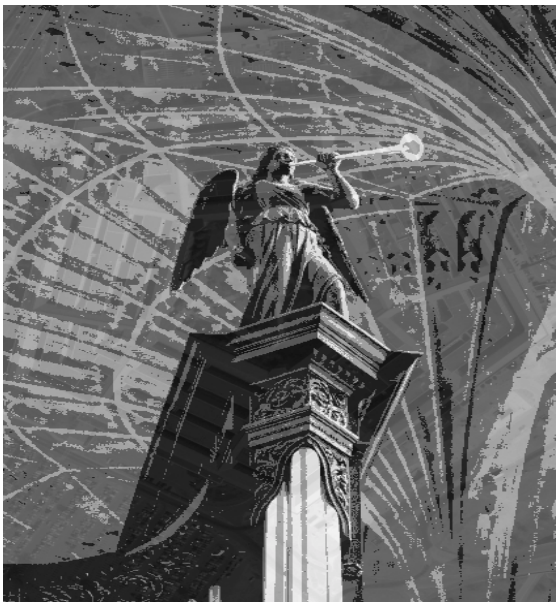
The 1st least significant bit of "Kings" has been replaced with the first most significant bit of "Pentagon." The extracted image is on the right.



The 2 least significant bit of "Kings'" have been replaced with the 2 most significant bit of "Pentagon"



The 6 least significant bit of "Kings'" have been replaced with the 6 most significant bit of "Pentagon"



Weaknesses of LSB Insertion

- Cover image must be selected carefully because of colour limitation
- LSBI is vulnerable to image manipulation, such as:
  - lossy data compression
  - cropping, scaling
  - image enhancement

Advanced Techniques

- Masking and Filtering
  - Create the watermarked image, then use it to hide information (embed information in significant area)
- Other algorithms and transforms
  - combine the compression algorithm with steganography
  - may manipulate image properties such as luminance
  - scatter message by using some algorithms and also use stego-key to provide extra layer of protection.

Conclusion and Comments

- *Steganography* is not intended to replace cryptography but to supplement it
- *LSB Insertion* is a quick and easy way to hide information, but
  - it is not robust. It is vulnerable to image manipulation including lossy data compression, colour correction, addition of caption, and geometric modification such as cropping, scaling.
  - It is not secure. It can not survive deliberate attack.
- *Masking and Filtering* is more robust than LSB insertion: the stego-message may survive image compression, clipping.

Conclusion and Comments (cont'd)

- Some *"algorithms and transforms"* for steganography allow the stego-information to be spread throughout the message so it looks "more like noise". Others allow the image to be converted to other formats, without any message losses.
- *Question: How to hide a message in a cover file?*